LETTERS TO THE EDITOR.

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Note on some Red and Blue Pigments.

THE following data are placed on record because interesting in themselves, and in the hope that they may be useful to others who have the opportunity to make further investigations.

(1) A little boraginaceous plant called *Eremocarya micrantha* (Torrey) is common in sandy places at Mesilla Park, New Mexico, flowering in April. A few days ago, Prof. E. O. Wooton called my attention to the fact that its roots are deep red, and stain herbarium paper. Curious to learn more about this peculiar coloration, I made some tests, with the following results:—The pigment is not soluble in water, but it readily dissolves in cold alcohol, forming a beautiful red solution. The roots, after being treated with alcohol, become white, showing that the pigment is entirely superficial, and is apparently an excretion from the root. The red colour is that of the normal or acid state of the pigment, but on adding enough liquor potassæ to make the solution alkaline, the colour immediately becomes a beautiful blue. An excess of strong caustic potash does not destroy the pigment until after a considerable time. Prof. A. Goss tested the delicacy of the colour-reaction in the presence of acids and alkalis, and found that a very small excess of one or the other would give the characteristic colour. The pigment is, of course, an anthocyan, very similar, at least, to litmus; and it may be that it can be utilised for the same purposes.

(2) It has been remarked more than once that whereas the hind wings of Acridiidæ (grasshoppers) are sometimes blue, sometimes red, and sometimes yellow, species living in the same locality, though of very diverse genera, will often have similarly coloured wings. In the Mesilla Valley we have common species with red and with yellow wings; but in the Organ Mountains, not far away, I found two species very abundant, both having blue wings, and otherwise coloured much alike, though of totally different genera. These were *Leprus wheeleri* and a *Trimerotropis* which I took for *T. cyaneipennis*, but which Mr. S. H. Scudder tells me is distinct and apparently undescribed. As the blue of the wings appeared to be certainly a pigmentary colour, and much resembled the vegetable anthocyans, I detached one of the wings of *Leprus wheeleri*, and boiled it in dilute hydrochloric acid. As I had hoped, but hardly ventured to expect, the blue at once became red. Heating the thus reddened wing in liquor potassæ did not change it back to blue, but caused it to turn yellow. I infer that the blue pigment has a red (acid) phase, but that strong alkali will destroy it altogether, leaving a yellow coloration which is of a different character. It is difficult to avoid the conclusion that the redness or blueness of the wings in these grasshoppers may result from the action of some environmental factor (*e.g.* the juices of plants eaten) upon the pigment, and that this accounts for the colour-similarity of diverse species living at the same place. Of course, this is not supposed to account for the similarity of the colours of the tegmina and thorax, of which the various shades of grey, red and brown resemble those of the rocks and ground.

T. D. A. COCKERELL.

Mesilla Park, New Mexico, U.S.A., April 17.

Valve Motions of Engines.

IN your number of December 14, 1899, Prof. John Perry mentions a diagram by Mr. Harrison. This diagram is the same as "Das bizentrische polare Exzenterschieberdiagramm" of F. A. Brix in the *Zeitschrift des Vereins Deutscher Ingenieure*, April 10, 1897.

There is only a small difference, as Mr. Harrison finds the distance OC by means of a circle with radius = length of connecting-rod, and Mr. Brix finds that distance by calculating it out of $\frac{R^2}{2L}$, (R = length of crank, L = length of connecting-rod). Now OC has not exactly that value, but the fault made therewith is much smaller than the fault made by describing the circle. Therefore the method of Mr. Brix is preferable to that of Mr. Harrison.

F. J. VAES.

Rotterdam, April 14.

MR. BRIX seems to have solved only the simple case of a valve worked by an ordinary eccentric. There are other good graphical solutions—for example, by Coste and Maniquet in a modified form of the Reauleaux diagram, which gave accurate results. Mr. Harrison's diagram is more general and is applicable to link and radial valve-gears and to all motions which are composed of a simple harmonic vibration with a small octave superposed. It may be used for velocities and accelerations as well as mere displacements. As to calculating the distance OC by the formula $\frac{R^2}{2L}$, instead of using the construction of the circular arc, this is a matter of no importance because there is no appreciable difference in the answers.

April 28. JOHN PERRY.

Drunkenness and the Weather.

I NOTICE in your issue of March 15 a communication from Mr. R. C. T. Evans, of Gray's Inn-road, W.C., calling attention to a probable error in my deductions in the paper which appeared in your issue of February 15, under the title "Drunkenness and the Weather." He says, "When a man is intoxicated and commits an assault, the result is entered in the police reports as 'assault,' the more serious offence overshadowing the less; so that in all probability many of the cases of assault referred to in the statement were also cases of drunkenness, but were not tabulated as such. Studying Prof. Dexter's curves in this light, we may reasonably conclude that the number of those arrested for drunkenness or its results, varies but little throughout the year."

Although his supposition seems a reasonable one, a fuller statement of the conditions of the study will show that the fluctuations of the "drunkenness" curve cannot be so easily accounted for.

First, the monthly occurrence of arrests for drunkenness for New York City is more than twice that for assault, even in the summer, when the former are at the minimum and the latter at the maximum for the year, and if we suppose that every person arrested for assault in the summer was also intoxicated and would have come into the hands of the law for that crime if he had not for the other, even this would not bring the drunkenness curve up to its normal for the winter months.

Second, the method of recording crime by the New York City Department of Police makes this practically impossible. Misdemeanours are there classified and recorded under 183 different headings. The two which I have compared are "assault and battery" and "intoxication." There are, however, four other classes of assault besides, one for "intoxication and disorderly conduct," equalling that of "assault and battery" in the annual number of arrests, besides one for "fighting." A letter just received from the Clerk of Police says, "The crime of intoxication and fighting—a drunken brawl—would be classified in the statistics as 'intoxication and disorderly conduct.'" A careful analysis of all the conditions would make it seem that only occasionally would arrests for "assault and battery" encroach upon the data of drunkenness. I believe they might sometimes do so, but not sufficiently often to materially influence the curve.

EDWIN G. DEXTER.

Greeley, Colo., April 17.

SOME SPECULATIONS AS TO THE PART PLAYED BY CORPUSCLES IN PHYSICAL PHENOMENA.

IN some experiments described in the *Phil. Mag.* October 1897, I showed that in the kathode rays there were present bodies whose mass was exceedingly small compared with the masses of ordinary atoms; these masses, which carry a charge of negative electricity, I called "corpuscles." Ever since then I have indulged in speculations as to the possibility of these corpuscles existing in a free state in ordinary matter not under the influence of the very intense electric field which are associated with the kathode rays. As recent work has produced some evidence of the free existence of these corpuscles, I have thought that these speculations might be of some interest to a wider circle than that to which they have hitherto been addressed. In the *Phil. Mag.*

(February 1900), I showed that these corpuscles existed in the neighbourhood of a hot wire and of a metal plate illuminated by ultra-violet light, and recently the discovery by Giesel, Curie and Becquerel of the magnetic deflection and electric charge carried by part of the radium radiation may be interpreted as indicating the existence of corpuscles in this substance.

I suppose, then, that there is a certain amount of what may be called corpuscular dissociation taking place in bodies; that some of the molecules of the substance are continually breaking up by the detachment of a corpuscle, and are being reformed by the arrival of another corpuscle; the result of this is that at each instant there are a certain number of free corpuscles with negative charges distributed throughout the body, while the corresponding positive charges are on the molecules of the body, the corpuscles are much more mobile than the molecules; indeed, in solids and liquids, the latter may be regarded as almost fixed in comparison with the former. We thus get the conception of a body permeated with corpuscles which are able under forces to move from one part of the body to another. We must remember that, as the particles are charged, any movement will be accompanied by electrical effects and, in general, a volume density of electrification.

The actual number of corpuscles free at any instant is the result of an equilibrium between the number of corpuscles produced by dissociation and the number which recombine. Thus if q is the number of corpuscles produced by dissociation in unit volume in one second, τ the time during which a corpuscle is free (*i.e.* the time which elapses between its departure from one molecule and its entry into another), n the number of free corpuscles in unit volumes, then when there is equilibrium $q=n/\tau$ or $n=\tau q=\lambda q/u$, if λ is the mean free path of the corpuscle and u its velocity of translation. In non-conductors we suppose that there are very few corpuscles, but that they are abundant in metallic conductors. Let us now trace some of the consequences of the existence of these corpuscles in a solid, and suppose for the moment that the positively charged molecules are fixed; if the corpuscles are acted upon by gravity (of which point we have no evidence), then in a vertical bar of metal the number of corpuscles in unit volume will be greater at the bottom of the bar than at the top, for just the same reason as the density of the air gets less as we go higher; thus in this case gravity would produce a displacement of electricity, the bottom of the bar being negatively and the top positively electrified. Again, in a rotating mass of metal the centrifugal force would tend to drive the corpuscles towards the surface; there would thus from this effect be an excess of the corpuscles near the surface and a deficit near the axis. Thus the outer parts of the metal would be negatively and the inner parts positively electrified, the rotation of the negatively electrified corpuscles being no longer completely balanced by that of the positively electrified molecules would give rise to a magnetic field; thus a large mass of rotating metal would act as a magnet. Again, suppose we place a piece of metal in a magnetic field, the action of the magnet on the moving corpuscles will make them describe curved paths, and we can easily see that the magnetic effect due to the particles moving in this way is in the opposite direction to that of the external magnetic field. Thus a metal containing these corpuscles would tend to act like a diamagnetic substance. Again, suppose the metal is exposed to an electric force X, the corpuscles will acquire an average velocity along x equal to $X\tau e/2m$, where m is the mass of a corpuscle and e its charge. Let us call this velocity vX, then the electric current across unit area is $nevX$; thus nev or $qe^2\lambda^2/2mu^2$ is the specific conductivity of the substance. If we suppose that u, the mean velocity of translation of the corpuscles, varies with the temperature in the same way as the velocity of translation of the molecules of a gas, mu^2 would be proportional to the absolute temperature, and the specific resistance would, considered as a function of the absolute temperature θ, vary as θ/q; if q, the amount of ionisation increases as the temperature increases, the resistance will vary more slowly than the absolute temperature; if q diminishes as the temperature increases, the resistance would vary more rapidly than the temperature. These corpuscles moving from place to place would carry not merely electric charges, but energy from one part to another; and since the coefficient of diffusion of these corpuscles is proportional to v, the thermal and electric conductivities would be proportional to each other. Again, when we have conduction of heat we have unequal streams of these corpuscles in opposite directions; thus the unequal deflection of their paths produced by a magnet would give rise to an electric displacement, and we should have an electromotive force at right angles to the magnetic force and to the temperature gradient, an effect discovered by v. Ettinghausen and Nernst. From the conductivity of the gas we can deduce the value of nev. We know the value of e, and hence another equation would enable us to determine n and v; for this purpose we turn to the Hall effect, but here the results are disappointing, for we can easily prove that when E^1 and E are the tranversal and longitudinal electric forces and H the magnetic force, $E^1/EH = \frac{v_1k_2 - v_2k_1}{k_1 + k_1}$, where v_1 and v_2 are respectively the velocities of the negative corpuscles and positive molecules under unit electric force, and k_1 and k_2 the values of k for these ions where k = pressure ÷ number of systems in unit volume. If both the negative corpuscles and the positive molecules behave like perfect gases, $k_1 = k_2$ and $E^1/EH = \frac{1}{2}v_1$, since v_2 is very small; thus, on this supposition, the Hall effect would give us the value of v; but there seems no reason to suppose that the positively electrified molecules in the solid would produce the same pressure as an equal number of molecules in the gaseous state, and thus though v_2 is small compared with v_1, k_2 may be so small compared with k_1 that k_1v_2 cannot be neglected in comparison with k_2v_1, and in this case the Hall effect would not be sufficient to determine v. The fact that the Hall effect is of different signs for different substances shows that we have to take into account both terms in the expression for E^1/EH.

Again, if different parts of a metal bar were at different temperatures, the "pressure" as it were of these corpuscles would be different at different parts of the bar, so that the corpuscles would tend to flow from one part of the bar to the other, and cause an electric displacement; thus difference of temperature would cause an electric displacement. This is the Thomson effect, measured by the "specific heat of electricity." The value of the "specific heat of electricity" will on this theory depend not only on the variation with temperature of the kinetic energy of a single corpuscle, but also on the way the dissociation constant q varies with the temperature. There are many other phenomena which can be interpreted in terms of these corpuscles, but these I must leave for another occasion.

J. J. THOMSON.

Cavendish Laboratory, Cambridge, April 30.

SCIENCE IN RELATION TO ART AND INDUSTRY.

AT the annual banquet of the Royal Academy on Saturday evening, Sir Norman Lockyer, in replying on behalf of science, made the following remarks upon the intimate relation between intellectual progress and the study of nature, and also upon the necessity for a more liberal provision for scientific work if England wishes to compete successfully with other nations struggling for industrial supremacy. Though the public mind may be